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ABSTRACT

This presentation considers the incidence, evaluation, and management of rotator cuff disease and injury. Pathogenesis, symptoms, physical findings, treatment (therapeutic and surgical), and prevention are discussed. It is noted that rotator cuff problems, common in athletes, are usually related to an error in training or lack of training. They can be successfully treated non-operatively although it may require several weeks or months to obtain a cure. Included are descriptions of exercises for rehabilitation of rotator cuff injuries. (CB)

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ROTATOR CUFF DISEASE AND INJURY--EVALUATION AND MANGEMENT

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Rotator Cuff Disease and Injury-
Evaluation and Management

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The shoulder joint has the greatest range of motion of any major joint in the body. This range of motion is possible due to the absence of a bony articulation which imparts stability to the joint, as is the case in the hip joint. The glenohumeral joint gets its stability from the joint capsule, the rotator cuff, and the shoulder girdle muscles. While the rotator cuff muscles help initiate abduction and contribute to internal and external rotation, their main function is to keep the humeral head firmly opposed to the glenoid during use. The rotator cuff muscles normally exert enough compressive force between the humeral head and the glenoid to overcome the shearing component of the deltoid muscle during abduction. This shearing force, if unopposed, would result in proximal migration of the humerus during abduction.

The subscapularis, supraspinatus, infraspinatus, and teres minor muscles form the rotator cuff. They originate about the scapula. Their tendons merge with the capsule of the glenohumeral joint as they insert into the proximal humerus. A bursa lies between the cuff and the overlying coracoacromial arch, which includes the anterior acromion, the coracoacromial ligament, the lateral most extent of the clavicle, and, in some patients, the coracoid process. It is against this arch that the cuff impinges.

PATHOGENISIS

As with most topics in medicine, there is not a concensus as to the cause of the impingement syndrome. Most authors agree that impingement occurs under the coracoacromial arch(especially the anterior acromion) when the arm is abducted and internally rotated. Most feel that the greatest damage occurs in the "watershed" area of hypovascularity near the insertion of the supraspinatus tendon. This area is more susceptible to overuse injury as it is slow to heal, and chronic minor injury can have an additive effect. As the cuff becomes inflamed, the muscles work less efficiently and the vertical shear component of the deltoid force causes the humerus to migrate superiorly. The cuff also becomes edematous, and both of these factors result in less space for the rotator cuff and cause further impingement.

This causes worsening of the inflammation and pain, and continued deterioration of function. This vicious cycle continues until treatment is initiated. If allowed to continue, a degenerative tear may occur.

Several entities are felt to make one more prone to rotator cuff problems. Previous injury to the acromioclavicular joint with secondary osteophyte formation increases one's risk as the space for the rotator cuff is decreased. Variations in the shape and orientation of the acromion are felt by some individuals to predispose certain patients to impingement problems. Glenohumeral instability increases the risk of developing impingement problems. However, probably none of these factors are as important to causing problems as is overuse of the shoulder resulting in fatigue of the cuff muscles. The cuff then no longer works in synchrony with the "primary movers", allowing the humerus to migrate superiorly and impingement to occur.

SYMPTOMS

People suffering from rotator cuff tendinitis often experience a dull ache over the anterior shoulder. The pain often radiates into the arm near the area of the deltoid insertion. Pain in the neck secondary to trapezius spasm is not uncommon. A pitcher usually complains of pain during the acceleration phase of throwing or immediately after ball release. Swimmers experience the pain during the reach and recovery phases of their strokes. Tennis players feel pain while serving or during an overhead volley. Activities of daily living requiring overhead lifting or reaching forward will cause discomfort. If asked, the patient will usually tell you they can't sleep on their side if the involved shoulder is down as this causes significant discomfort.

When taking the history, it is crucial to inquire about the athlete's training schedule. As previously mentioned, this is usually an overuse syndrome related to a training error. A change in mechanics can also place abnormal stress on the shoulder. Mechanical problems are often due either to a conscious effort by the athlete to change their technique or to the athlete continuing to perform after fatigue of muscles occurs. The athlete will then often begin to use abnormal mechanics to rest the fatigued muscles. Mechanical problems can usually be picked up by a coach, but occasionally will require slow motion cinematography to find the problem.

Problems of the rotator cuff can occur on an acute basis after an injury, usually a fall on the flexed elbow which results in the rotator cuff being compressed between the upwardly thrusting humeral head and the acromion.

Tears in the cuff also occur in conjunction with fractures of the greater tuberosity and with shoulder dislocations.

PHYSICAL FINDINGS

Physical examination begins with observing the contour of the shoulder. In long standing impingement syndromes, atrophy of the supraspinatus muscle can be observed as a relative emptiness of the supraspinatus fossa. Wasting of the deltoid muscle and/or the infraspinatus muscle may also be present, but are somewhat more difficult to appreciate.

The patient will classically complain of pain during active abduction between 60 degrees and 120 degrees, the so called painful arc. Full abduction may or may not be present. Flexion may be painful between about 80-120 degrees, but usually full flexion is possible. Both external and internal rotation are usually decreased. It is important to check passive motion also. Lack of full passive range of motion is indicative of adhesive capsulitis or some type of mechanical block.

Tenderness to palpation is characteristically maximal at the supraspinatus insertion into the greater tuberosity and along the coracoacromial arch. Tenderness over the insertion of the infraspinatus, subscapularis, or long head of the biceps indicates involvement of these structures. The long head of the biceps is often involved in rotator cuff tendinitis.

There are several maneuvers I like to use in order to diagnose rotator cuff tendinitis. I first perform the impingement test by passively flexing the arm while stabilizing the scapula to prevent its rotation. Pain with this maneuver is indicative of impingement. I also perform this test with the arm flexed to about 90 degrees and internally rotated. I believe this is a more sensitive test. However, always check this maneuver on the assymptomatic side applying the same amount of pressure. If excessive force is used during this test, discomfort can be elicited in a normal shoulder. The supraspinatus test is performed with the patient maintaining both arms at 90 degrees of abduction, approximately 30 degrees of forward flexion, and internal rotation so that the thumb is pointed to the floor. The patient then attempts to resist downward pressure at the elbow. Pain or weakness with this test is indicative of rotator cuff tendinitis. The weakness may be secondary to pain, muscle atrophy, or a tear of the cuff muscle. This test fairly well isolates the function of the supraspinatus muscle. Another valuable maneuver is to support the patient's elbow with one of your hands with the arm positioned at about 80 degrees of abduction.

The patient is then asked to externally rotate the arm while you apply resistance with your other hand . Pain with this maneuver is suggestive of rotator cuff tendinitis.

Involvement of the biceps tendon is checked by two tests. The biceps resistance test is performed by having the patient flex the arm with the elbow extended and the forearm supinated. Pain while attempting to resist downward pressure on the forearm is indicative of involvement of the long head of the biceps tendon. Pain with resisted supination of the forearm with the elbow at the side (Yergason's sign) also suggests involvement of the biceps tendon. Weakness of external rotation may be indicative of a large cuff tear involving the infraspinatus. This is rare in an athlete.

After performing these tests and checking the range of motion, I perform the Neer injection test, in which 8 to 10 cc's of 1.% Xylocaine is injected into the sub-acromial space. If I feel fairly certain that the patient does not have a rotator cuff tear, I will include 6 milligrams of betamethasone in the injection after discussing the pros and cons of steroids with the patient. The Neer injection test then becomes both a diagnostic and therapeutic test. After waiting a few minutes, I repeat the first three diagnostic maneuvers and the range of motion examination. The range of motion may or may not be improved, but pain and weakness should be markedly reduced or eliminated. If pain is relieved but weakness persists, this may indicate a long standing problem and muscle atrophy with or without a cuff tear. If the pain is not relieved, then you must reconsider your diagnosis. The differential diagnosis for rotator cuff tendinitis includes glenohumeral instability, labral tears, acromioclavicular joint arthrosis, the groove syndrome, quadrilateral space syndrome, cervical spondylosis, neoplasm, and adhesive capsulitis.

Radiographics studies can help confirm the diagnosis. Plain x-rays may show degenerative changes at the acromioclavicular joint. The anterior acromion may demonstrate abnormal inferior tilt or the presence of osteophytes. Upward migration of the humerus is indicative of pathology. An acromio-humeral distance of less than 9 mm suggests rotator cuff disease, whereas a distance of less than 6 mm suggests a cuff tear. Sclerosis or cyst formation about the greater tuberosity also suggests pathology. Arthrography has long been the standard for diagnosing tears in the rotator cuff. Diagnostic ultrasonography in the hands of an experienced radiologist may be a more sensitive test.

Treatment

Therapeutic measures depend on the severity of the disease as well as the patient's

level of activity and functional expectations of the shoulder. Neer divides the disease process into three stages. Stage I is the edema and hemorrhage stage, typically in patients under 25 years of age. Stage I disease is usually reversible with conservative treatment. In Stage II, fibrosis and tendinitis are present, and this may or may not respond to conservative treatment. This stage is more common in an older patient population. Stage III disease is characterized by osteophyte formation and tendon rupture. It is typically seen in patients over 40 years in age, and usually requires operative treatment.

Once a diagnosis of rotator cuff tendinitis is made, an initial conservative trial is indicated. I use a modification of Allman's ARISE protocol. Each individual has a different response capability, and the program may have to be sped up or slowed down to fit each patient. The following is a generalized treatment schedule.

In Phase I, the athlete is started on an oral anti-inflammatory medication. As mentioned earlier, the patient may have already received a subacromial steroid injection at this time. For the first two weeks, the athlete avoids the offending activity totally. The patient also avoids any overhead activity. A swimmer may work out with a kick board. A baseball player may move to a position that allows mostly short underhand throws, such as second base. Another choice is to play a position that requires little throwing, such as first base. The patient goes through a daily routine consisting of accuscope treatment to the shoulder followed by Allman's early rehabilitation exercises* and ending with a twenty minute ice massage. After two weeks, the acute inflammation and pain are usually resolved. If not, Phase I is continued until this goal is accomplished.

In Phase II, the patient continues on his or her anti-inflammatory medication. The patient warms up with jogging or cycling until a light sweat is broken. Moist heat may be applied to the shoulder to help increase the local circulation. The patient then goes through a series of gentle stretching exercises, followed by Allman's intermediate rehabilitation exercises. The patient then repeats the stretching and finishes again with a 20 minute ice massage. Phase II continues for roughly two to four weeks.

The Phase III routine is the same as Phase II, except that the patient progresses to Allman's advanced rehabilitation exercises and cuff strengthening exercises from Jobe's booklet "Shoulder and Arm Exercises for Baseball Players". Also the patient resumes their sport activity in a separate work out. A throwing athlete will begin a long toss-short toss program (see addendum). A swimmer begins swimming for 5 minutes per day.

The swimming is increased by 5 minutes per day per week as allowed by pain. If the patient is unable to start one of these programs, they are not ready to begin Phase III and should return to Phase II activities. The athlete is advised to warm up and stretch prior to their sport activity. They should stretch after their sport activity and apply ice for twenty minutes to the shoulder. The sports specific work out can be performed the same day as the previously described work out or on alternate days. If the sports specific work out is performed on the same day as the strengthening and stretching work out, it should be performed at a separate time of the day. Once a baseball pitcher finishes the long toss- short toss program, or a swimmer is up to 30 minutes swimming per day without pain, they are ready to resume normal activity. It is recommended that the athlete perform the Phase III stretching and strengthening exercise regimen two or three times a week to maintain condition of the rotator cuff.

If a patient has a history or examination suggestive of an acute rotator cuff tear, they are started on a modified Phase I program in which gentle passive and active assisted motion exercises are substituted for Allman's exercises. If the patient is not markedly improved after two weeks, an ultrasound and arthrogram is performed. If a cuff tear is found, an operative procedure is usually recommended. If no cuff tear is found, they continue on the routine conservative regimen. A subacromial steroid injection may be recommended at this time.

SURGICAL TREATMENT

In the vast majority of cases, conservative treatment will be successful <u>if</u> the patient is compliant. In those cases where symptoms continue after an honest attempt at conservative treatment, then a surgical procedure may be beneficial. If a patient has not been compliant with the conservative treatment regimen, there is little chance of a successful surgical outcome. Even in the best of circumstances, the athlete may not return to their pre injury level of competition.

My standard operation is the anterior acromioplasty and coracoacromial ligament resection. The distal clavicle may be resected if there is evidence of degenerative disease in the acromioclavicular joint, and if the acromioclavicular joint was tender in the pre operative exam. Occasionally the inferior portion of the joint may be beveled if there are osteophytes present inferiorly but the joint itself is not severely degenerated or symptomatic. Any rotator cuff tears are addressed during the procedure.

Recently, arthroscopic techniques have been used to decompress the subacromial space. The advantages of an arthroscopic procedure over open acromioplasty include cosmesis, shorter rehabilitation time, and the ability to assess the underside of the rotator cuff and determine the presence or absence of pathology in the glenohumeral joint. I believe the major advantage of an arthroscopic acromioplasty is the fact that the surgeon does not have to take down the origin of the deltoid muscle from the anterior acromion. Early experience with arthroscopic acromioplasty has been encouraging.

PREVENTION

The best treatment by far of a rotator cuff problem is prevention. Prevention can only be accomplished by a combination of quality coaching, general conditioning, and specific strengthening and stretching exercises. A good coach can help correct poor mechanics that can result in problems. Good cardiovascular fitness is crucial. It helps delay the onset of fatigue, when an athlete tends to being using poor mechanics. I have already discussed the appropriate strengthening and stretching exercises. A strong and flexible rotator cuff is less prone to injury. In the case of a pitcher or tennis player, it is important to keep the trunk and lower extremities strong, as the large muscle groups in these areas are the major sources of power for throwing or serving. Failure to use these muscles results in too much stress being placed on the shoulder girdle muscles. A pitcher should maintain some type of off season throwing program as a sports specific exercise to help keep the rotator cuff muscles and the trunk and lower extremity muscles involved in the throwing action working synergistically.

SUMMARY

Problems of the rotator cuff are common in athletes. These problems are usually related to an error in training or lack of training. In most cases, they can be successfully treated non operatively, although it may require several weeks or months to obtain a cure. Surgery is indicated in those cases resistant to an adequate conservative treatment regimen. However, the patient may not return to their pre operative level of competition. Therefore, prevention of the injury by using proper mechanics and maintaining good cardiovascular fitness as well as shoulder strength and flexibility is much preferable to treating an injury.

* Copies of exercises will be available at the conference.

ADDENDUM

Long toss- Short toss program

1. Patient warms up sufficiently to break a sweat.
2. Patient goes through stretching routine.
3. Patient makes a few lazy throws at a distance of about 10-15 feet.

**4. Patient performs long toss from deep center field, throwing to second base. Patient throws continuously for 5 minutes, paying strict attention to using proper body mechanics.

**5. Patient performs short toss for 5 minutes, paying particular attention to proper body mechanics. The patient should not throw any breaking pitches.

6. Patient repeats stretching exercises and does ice massage to shoulder for 20 minutes.
7. Patient performs this program 3 to 5 days per week.
8. Patient may perform the program twice daily.

	* Long toss	*Short toss
Stage I	Ball just rolls into second base.	1/2 speed at 30 feet
Stage II	Ball gets to 2nd base on 4 or 5 bounces	1/2 speed at 60 feet
Stage III	Ball gets to 2nd base on one bounce	3/4 speed at 60 feet
Stage IV	Ball gets to 2nd base on the fly	Full speed at 60 feet
Stage V	Ball gets to 2nd base on the fly	Begin throwing off mound; begin throwing breaking pitches

Pitcher advances to the next stage every one to two weeks as allowed by pain. If pain is experienced, patient should regress one stage.

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EARLY REHABILITATION EXERCISES

(FOR PHASE I)

1. GRIPPING EXERCISES- A tennis ball, grip strengthener, or other resistive device is squeezed at various points along the shoulder arc of motion from full abduction-flexion-external rotation to full adduction-extension-internal rotation. The gripping action is maintained for five seconds at each position. Positions which are painful should be avoided.

2. PENDULUM EXERCISE- Lean forward with the trunk flexed to near 90° at the hips. Support the trunk with the opposite arm on a stool or a bench. Hold a light weight (2 to 4 pounds) in the involved hand. Swing the arm like a pendulum in both a clockwise and a counter clockwise direction. Do each with the palm facing forward and backward. Do each of the 4 variations for a minute each.

3. LOCK-OUTS- Lie supine and hold barbell over chest with elbows extended and hold for ten seconds. Repear five times. Start with light weight- about 25 pounds total counting the bar and weights. As symptoms improve, progress by widening the grip up to 20 to 30 inches, then increase the weights. It is best to use free weights.*

4. SHOULDER SHRUGS- Hold a barbell with 25 pounds total weight with an overhead grip in front of the thighs. Leave the elbows straight, and shrug the shoulders. Hold for ten seconds and repeat five times. Progress as tolerated by pain by first widening the grip (up to 30 inches) and then by increasing the weights.

5. LATISSIMUS SETTING- Grab a chinning bar with an overhand grip and set the latissimus muscle for ten seconds. Repeat five times. As allowed by pain, progress to suspending partial and then full weight from the bar. Further progression is accomplished by widening the grip.

* Never use free weights without adequate spotters.

INTERMEDIATE REHABILITATION EXERCISES

(For Phase II)

1. DUMBBELL FLIES- While standing, a light weight (2 to 5 pounds) is rotated in small circles in front of the body and to the side of the body. The circles are performed in both a clockwise and counter clockwise direction. A set consists of twenty circles. Do three sets.

2. BENCH PRESSES- Progress from the lockouts to a full range bench press with 25-50 pounds. Do three sets of 25 repetitions each. Use free weights.

3. ROWING- Start as in the shoulder shrugs and raise the weight so the bar is under the chin. Use 10 to 50 pounds. Do three sets of twenty. Widen the grip as allowed by pain.

4. LATISSIMUS PULL-DOWNS- Grab the bar with an overhand grip with the hands shoulder width and pull down to the back of the neck. Use 25 to 100 pounds. Do three sets of twenty.

5. SUPRASPINATUS SETS- Start with the arm at the side and slowly raise the arm about 30° forward from straight lateral. Keep the thumb pointed toward the floor, and the elbow straight. Raise the arm to just below shoulder level, the slowly lower. Use 2 to 10 pounds. Do three sets of twenty.

ADVANCED REHABILITATION EXERCISES

(For Phase III)

1. OVERHEAD PRESSES- Perform overhead presses behind the neck. Use 25 to 100 pounds. Do three sets of twenty.

2. INCLINE PRESSES- Do bench press on 30° and 60° inclines. Use 25 to 100 pounds. Do three sets of twenty.

3. DIPS- Perform dips on parallel bars close to shoulder width. Do three sets of twenty. Advance by widening the bars and hanging weights around the neck.

4. PULLOVERS- Lying supine on a bench with the head and neck off the end of the bench, pull the weight from the floor to the chest. Perform three sets of twenty. Do with elbows bent and with elbows straight. Use 10 to 50 pounds.

JOBE'S EXERCISES

(For Phase III)

1. INTERNAL/EXTERNAL ROTATORS (0°)- Lie supine with the elbow by your side and the arm on the edge of the table. Start with the arm pointed to the ceiling, then externally rotate at least to the point where the forearm is parallel to the floor, then return to the upright position. Lie on the side opposite the involved shoulder. Keep the elbow at the side. Start with the forearm across the body, then externally rotate so the forearm is as close as possible to being perpendicular to the floor, then return to the starting position. Use 2 to 5 pounds. Do three sets of twenty. Each exercise can also be done with pulley machines while standing.

2. INTERNAL/EXTERNAL ROTATORS (90°)- Lie supine with the shoulder abducted 90° and the arm supported by the table. Start with the forearm perpendicular to the floor, then alternately rotate internally and externally so the forearm is parallel to the floor. Perform the exercises in a similar fashion while prone. Use 2 to 5 pounds. Do three sets of twenty. These exercises can also be performed with a pulley machine.

3. SHOULDER ABDUCTION- With a barbell in hand, slowly raise arm to the side and then directly overhead, then slowly lower to the side. Keep elbow straight. Rotate the arm so that at 90° the palm faces forward, and at full abduction the palm faces the opposite shoulder. Use 3 to 10 pounds and do three sets of twenty.

4. SHOULDER FLEXION- With a barbell in the hand, raise the arm forward until the weight is directly overhead, then slowly lower. Keep elbow straight. Use 3 to 10 pounds. Do three sets of twenty.

NOTE: On the previous pages, suggested weights are given for several exercises. These weights may well have to be adjusted for different athletes. If the athlete cannot do 10 repetitions in a set, the weight is too heavy. If the athlete can easily do more than 25 repetitions in all 3 sets, the weight is too light. The goal is not bulk strength, but rather conditioning, flexibility and functional strength.

The above exercises relate to the shoulder. In most athletes, and especially in pitchers and tennis players, it is absolutely mandatory to maintain strength and flexibility in the trunk and lower extremities.

STRETCHING EXERCISES

Stretching should be done after warming up to the point of breaking a sweat. Stretching should be done gently and with steady, gradually increasing pressure. Never force the stretch to the point of pain. Never bounce or jerk while stretching.

1. 90° CUFF STRETCH- Lie supine with the shoulder at the edge of the table in 90° abduction and the elbow at 90° flexion. Hold a 3 to 5 pound weight in the hand, and allow the weight to gently pull the hand in external rotation. DO NOT TIE THE WEIGHT TO YOUR HAND. An alternative to using a weight is to gently push the arm into external rotation with a stick.

2&3. Perform exercise #1 with the shoulder at 135° and 150°. An athlete suffering from anterior glenohumeral instability may be unable to perform these stretching exercises.

4. POSTERIOR CUFF STRETCH- Assume the same position as in exercise #1, but allow the arm to gently internally rotate. The posterior cuff can also be stretched by pulling the arm across the body with the opposite arm. This exercise may cause problems for athletes with posterior glenohumeral instability.

5. INFERIOR CUFF STRETCH- Place the hand of the affected shoulder on the posterior aspect of the opposite shoulder. Gently pull on the elbow with the opposite hand.